



U. S. FOREST SERVICE

RESEARCH NOTE LS-57

LAKE STATES FOREST EXPERIMENT STATION • U. S. DEPARTMENT OF AGRICULTURE

Seasonal Height Growth Patterns of Sugar Maple, Yellow Birch, and Red Maple Seedlings in Upper Michigan

Studies of the seasonal height growth patterns of tree species are common in the United States. Species of the northern hardwood type have been included in a few of these studies, but the height growth characteristics of northern hardwoods in Upper Michigan have not previously been reported. The results of observations in the latter area during 1959 and 1960 are presented here.

The study was conducted on the Upper Peninsula Experimental Forest, about 20 miles south of Marquette, Mich. The elevation is nearly 1,100 feet above sea level and about 450 feet above the level of Lake Superior, approximately 10 miles to the north.

Winter and summer temperatures contrast strongly. The average temperature for July is about 64° F., and the maximum for the summer is seldom higher than 90° F. The average January temperature is around 15° F., but readings of -20° F. are quite common. The average frost-free season is 93 days. The precipitation averages nearly 33 inches per year, and is distributed quite favorably, approximately 3 inches per month during the growing season. Annual snowfall averages about 100 inches per year.

Study Methods

Natural seedlings of yellow birch (*Betula alleghaniensis* Britton), sugar maple (*Acer saccharum* Marsh.) and red maple (*Acer rubrum* L.) were studied. These ranged from

0.8 to 4.6 feet tall, with 90 percent of them between 1 and 3 feet. Growth, in hundredths of feet, was measured on the dominant leader from the base of the bud scale scars to the tip of the terminal bud at approximately weekly intervals until elongation practically ceased. A final measurement was taken around the first of September.

In 1959, the study included birch under hardwood-hemlock stands of 30 and 90 square feet of basal area per acre and sugar maple under practically pure sugar maple stands of 30 and 125 square feet. In 1960, red maple was added to the study, and all samples were located in a partially-cut hardwood-hemlock stand containing about 90 square feet of basal area per acre.

Fifty seedlings (5 groups of 10) of each species under each stand condition were tagged for study. The maximum distance between any two seedlings of a group was 15 feet, and in most cases less than 10 feet. The shade conditions for groups within each stand were quite similar. All groups, regardless of stand density, received intermittent sunlight and shade during the day.

During the study a number of seedlings were lost because of injury to the growing tip, caused mostly by deer browsing and insect feeding. In 1959, 67 of the 200 seedlings tagged for study were damaged, and in 1960, 33 of 150. These seedlings are not included in the data presented here.

Results

In 1959, sugar maple began growing around May 13. The seedlings in the open environment started growth a day or two later than those under the dense stand. The latter completed 90 percent of their elongation by May 31, a period of 18 days, but the seedlings in the open took about 24 days (fig. 1). In both environments shoot growth of the seedlings was nearly complete before the overstory trees were in full leaf. The average elongation was 0.22 feet in the open and 0.16 feet under the dense stand.

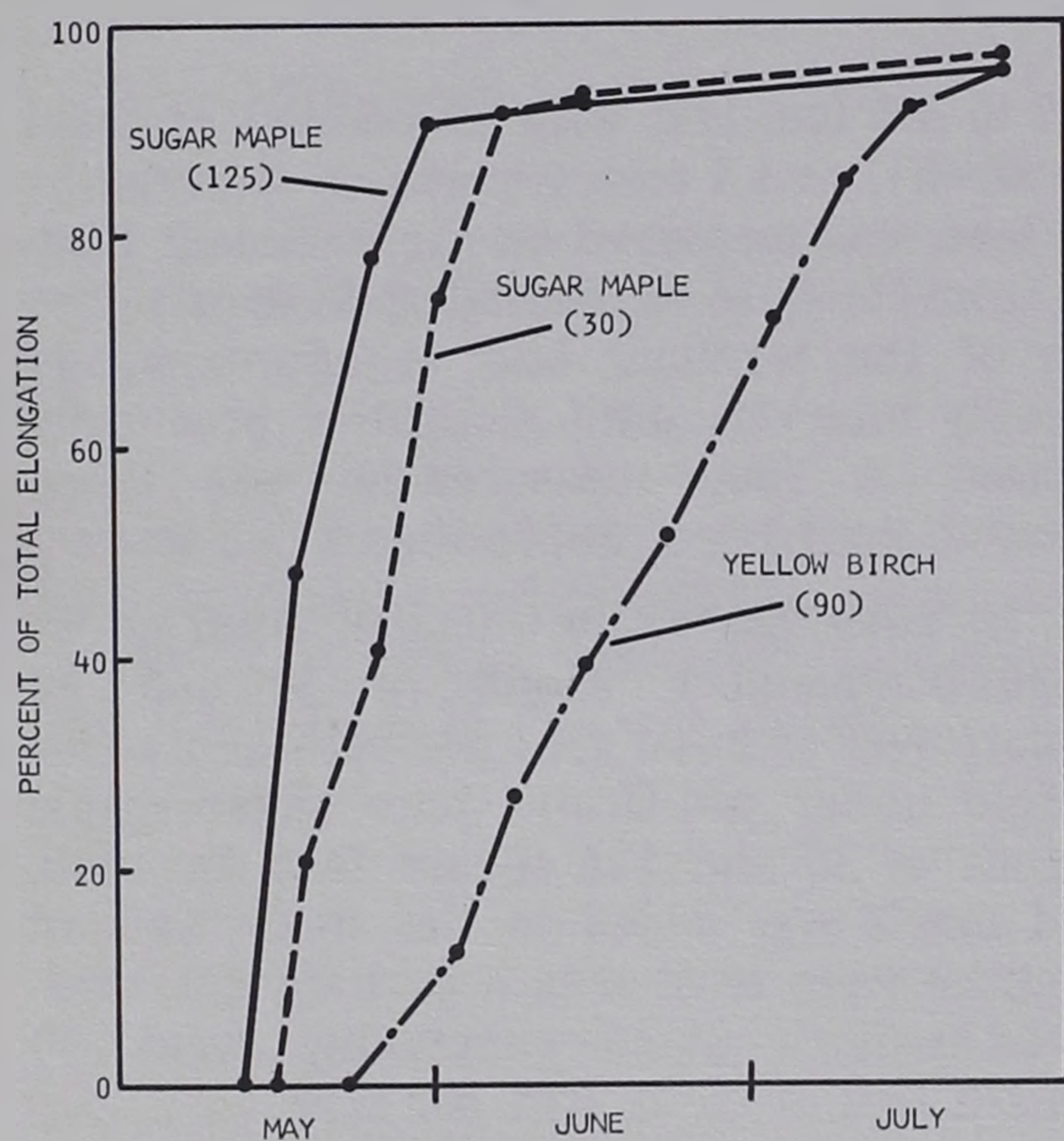


FIGURE 1. — Seasonal height growth patterns, 1959. Stand density in square feet of basal area per acre of overstory trees is shown in parentheses.

Yellow birch in 1959 broke dormancy about May 22, 9 days later than sugar maple. Again growth in the open commenced a day or two later than under the dense overstory. Under the dense stand the average elongation was 0.32 feet, and 90 percent of the growth was completed in 52 days. Data on the open stand are not available because deer clipped the faster growing seedlings. However, previous to the browsing in early July,

the average height growth was greater under the open stand; apparently the birch would have shown the same trend as sugar maple — greater elongation and a later and longer growing period in the open.

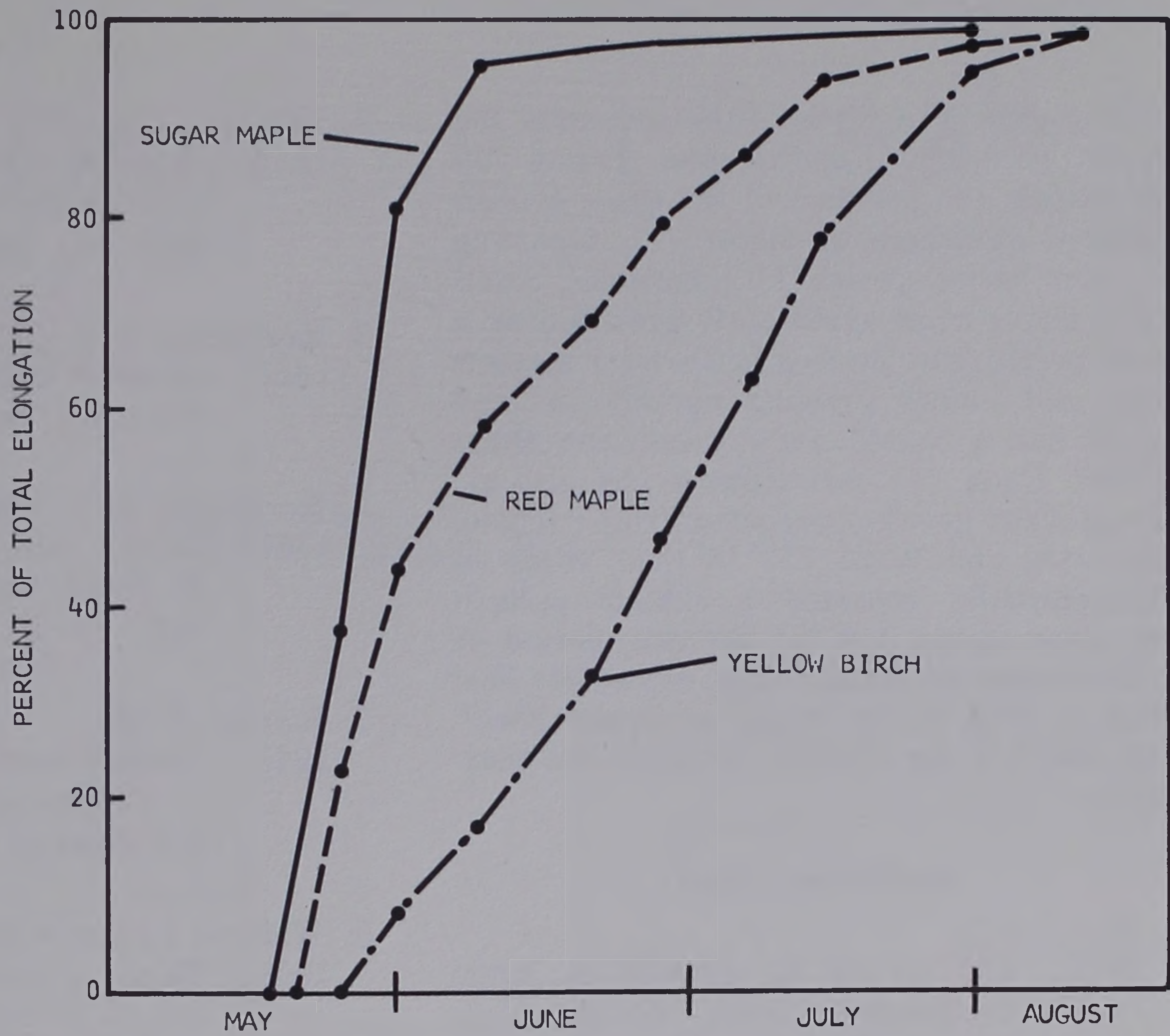
Growth in 1960 began 5 days later than in 1959. Sugar maple commenced height growth around May 18, 2 days before red maple and 7 days before yellow birch (fig. 2). The average elongation, in feet, was 0.31 for sugar maple, 0.37 for red maple, and 0.66 for yellow birch. The growth period for sugar maple was very short, with 90 percent taking place in 17 days. That of red maple and yellow birch was more gradual, these species taking 54 and 62 days respectively to complete 90 percent of their growth.

The average height growth of both sugar maple and yellow birch under dense overstories was about twice as much in 1960 as in 1959. However, the growth patterns of each were quite similar both years (figs. 1 and 2). Furthermore, individual sugar maple seedlings showed quite uniform seasonal growth patterns even though the total elongation varied considerably. On the other hand, the growth patterns of individual red maple seedlings, even those growing side by side, showed outstanding differences. Some behaved like sugar maple with a short growing period, while others showed a slower acceleration and later climax similar to yellow birch. Seedlings which followed the latter course had the greatest elongation. Five red maples also had a second flush of growth after slowing down in early June. The most extreme example of second flushing grew as follows:

Date measured	Periodic growth (feet)	Date measured	Periodic growth (feet)
May 25	0.16	July 6	0.39
May 31	0.23	July 14	0.41
June 9	0.05	Aug. 1	0.49
June 20	0.01	Aug. 11	0.05
June 27	0.37	Sept. 2	0.02
Total			2.18

Note the second flush of growth after the June 20 measurement. The total growth dur-

FIGURE 2. — Seasonal height growth patterns in 1960 of seedlings growing under an overstory of 90 square feet of basal area per acre.



ing the preceding month was quickly surpassed. The erratic growth of these red maple was not related to any apparent seedling characteristic or microclimatic factor. The seasonal courses of growth of individual yellow birch seedlings were not as uniform as those of sugar maple but considerably more so than red maple.

Discussion

There is little doubt that the sugar maple in this study made its current elongation according to the axiom that height growth of deciduous trees is made at the expense of prior-year rather than current photosynthesis. This species is putting on height growth as the leaves are unfolding, and the major portion is completed before the leaves reach full size. Kozlowski and Ward (3)¹ suggest that there may be a difference between deciduous species with regard to this phenomenon; that is, species that continue to grow all

summer may begin growth using stored carbohydrates and sometime later may utilize the products of current photosynthesis. Yellow birch and red maple may follow this latter course, especially the red maples that showed the second flush of growth after practically ceasing elongation for about a 2-week period.

Although height growth is apparently controlled for the most part by heredity and only large fluctuations of the factors affecting the physiological processes will alter the seasonal patterns, the growth patterns among individual trees within a species may vary somewhat (4, 6). Kozlowski and Ward (4) found that the variations between individuals were much greater for some species than for others. The red maple of this study showed large individual differences, while the yellow birch patterns varied to a lesser extent. The patterns of the sugar maple seedlings, on the other hand, were much the same.

¹ Numbers in parentheses refer to Literature Cited at end of Note.

The growth patterns of the species at the Upper Peninsula Experimental Forest follow closely the patterns of the same species reported elsewhere. Kienholz (2), reporting on a number of species in Connecticut, found sugar maple made rapid early growth over a short period. The birches had a later acceleration and longer growing period; and red maple had a course midway between these species. Cook (1) and Reimer (5) also reported short growing periods in sugar maple. Kozlowski and Ward (3) in their study in Massachusetts, reported a similar pattern for sugar maple, but the growing period of their nursery-grown seedlings was nearly four times as long as the period in Upper Michigan, which is the shortest found in the literature.

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